FUEL CELL BUS PROGRAMS

Fuel Cells in California Workshop

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California Energy Commission
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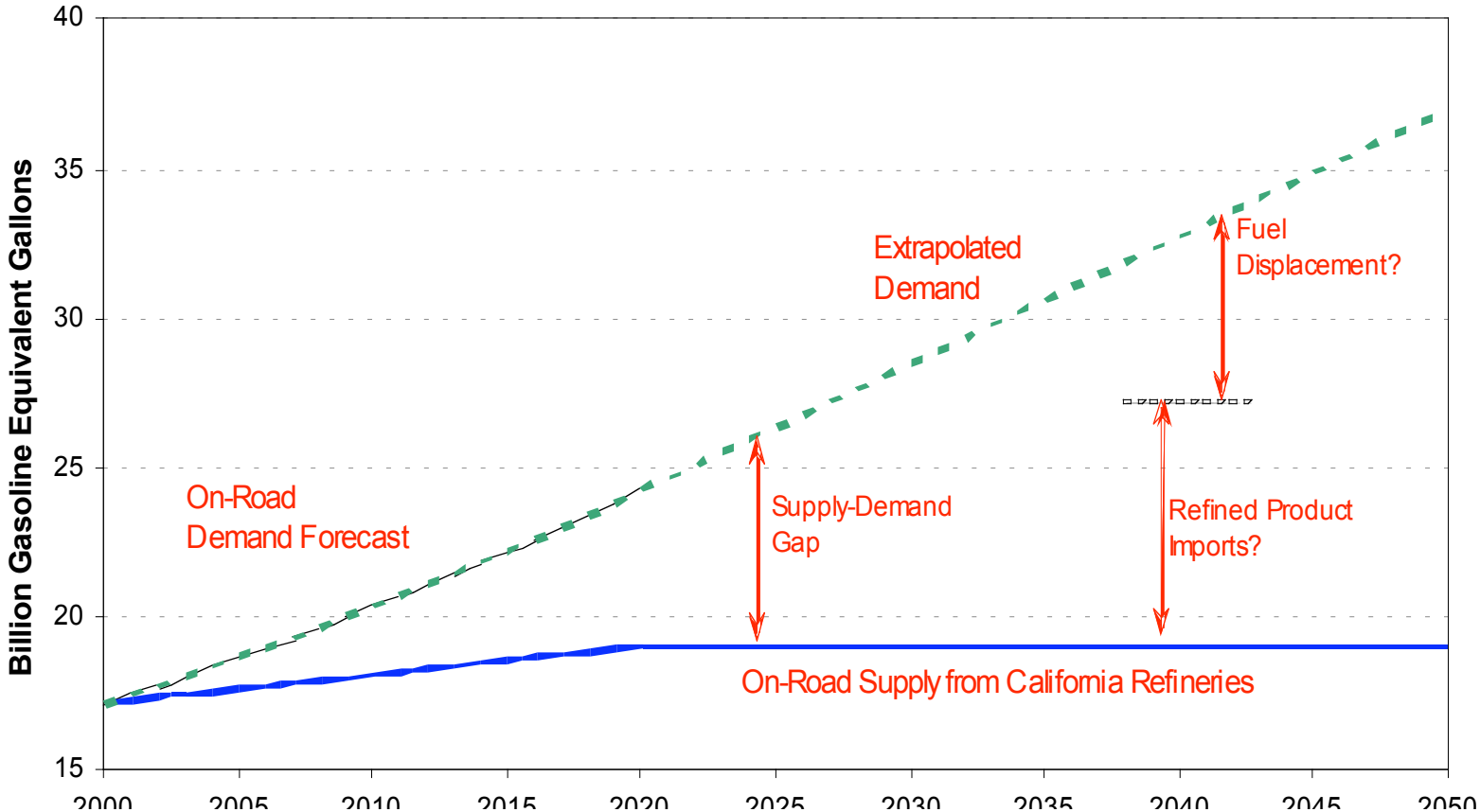
Background

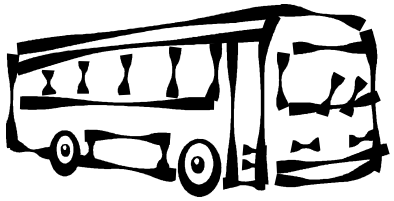
- Goal: Increase non-petroleum fuels use to 20% by 2020
- Adopted in *2003 Integrated Energy Policy Report*

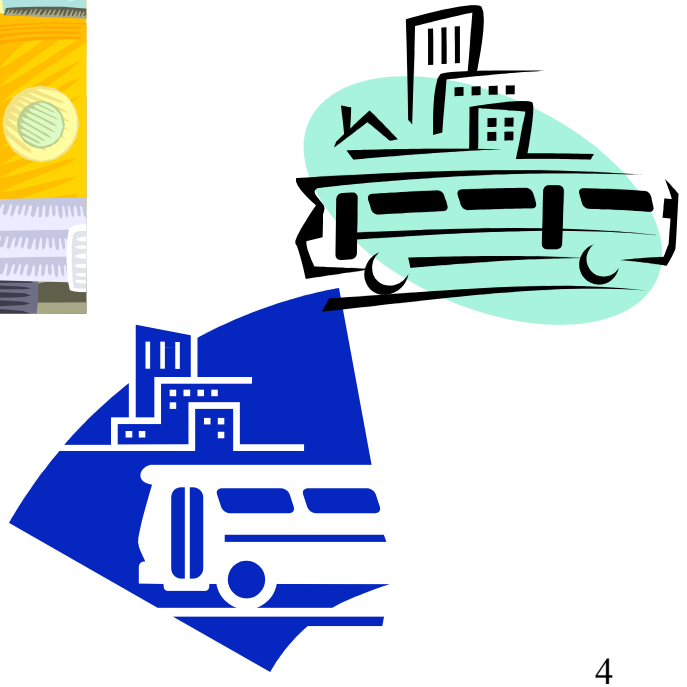
California's Problem with Petroleum Dependence



Role of Hydrogen Buses in Petroleum Reduction

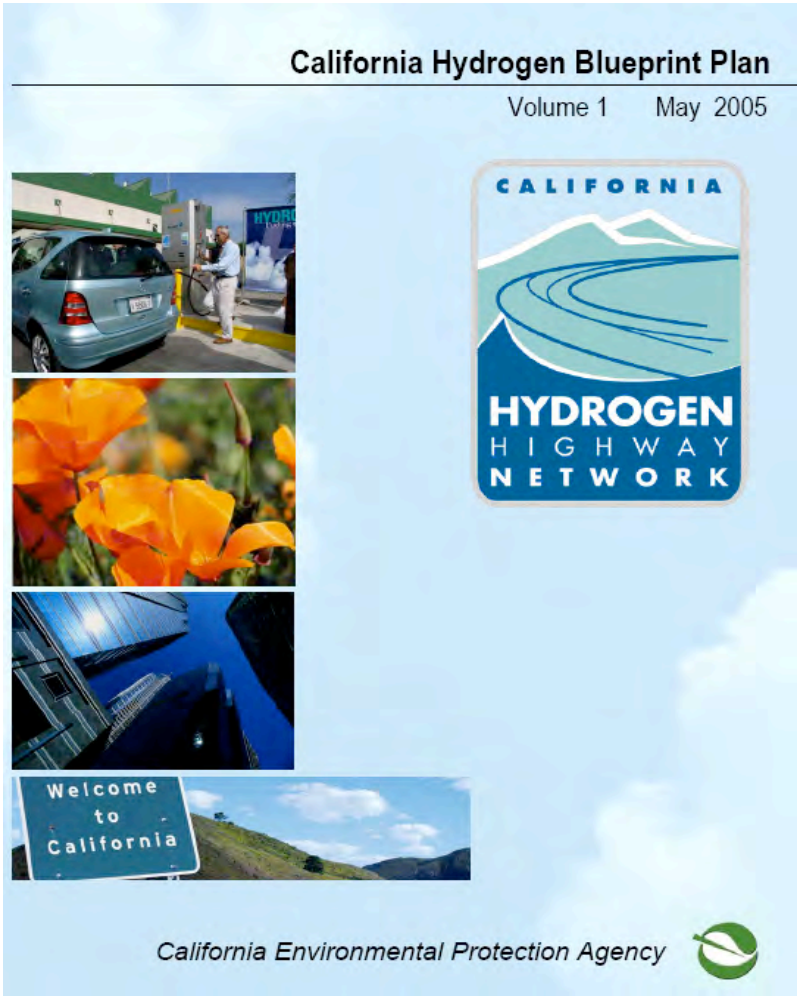
- California Bus Population - 56,000 (8,000 in transit agencies)
- Non petroleum buses - 4,400
- Estimated diesel use in buses– over 750 million gallons per year





California Goals for Hydrogen Buses

Phases	Number of Heavy Duty Vehicles
Phase I	10
Phase 2	100
Phase 3	300

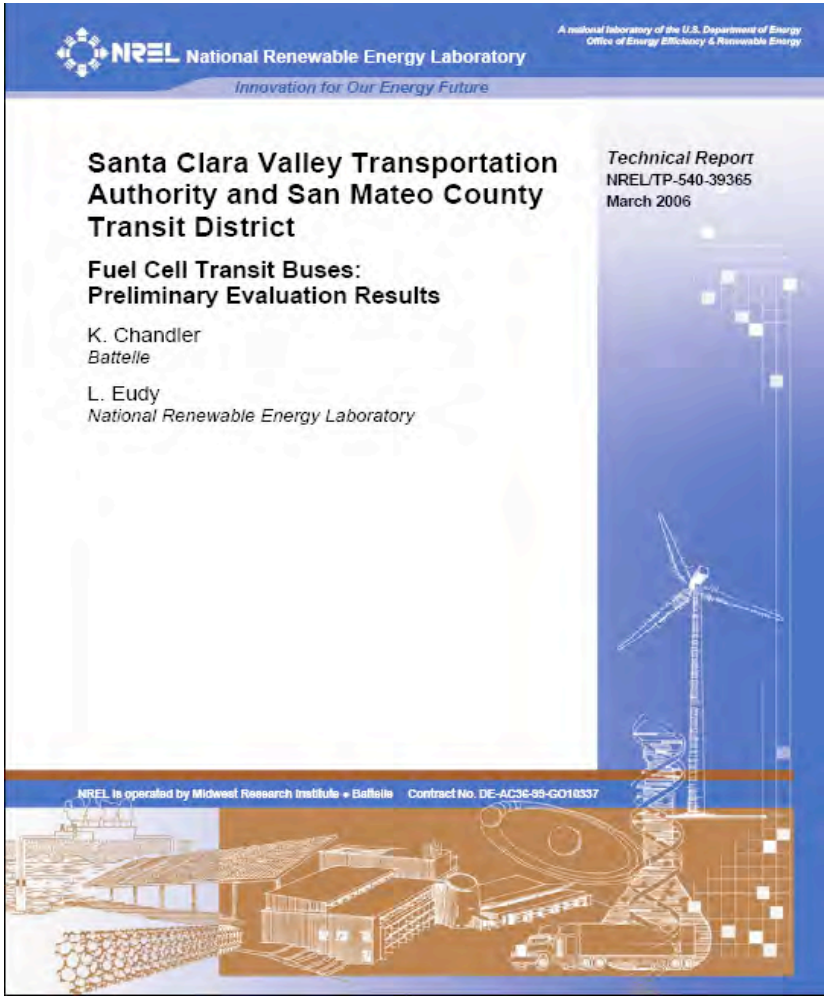


Santa Clara Valley Transportation Authority

- 3 buses in revenue service
- Displayed at various outreach events.
- Used on a variety of routes.

Mid Term Fuel Cell Bus Data

- As of October 2005 – almost 25,000 miles accumulated
- Average fuel economy – 3 miles per kg hydrogen, 3.45 miles per diesel equivalent gallon
- Higher maintenance costs $4.26 per mile vs. $0.59 per mile diesel



Fuel Economy for VTA Buses

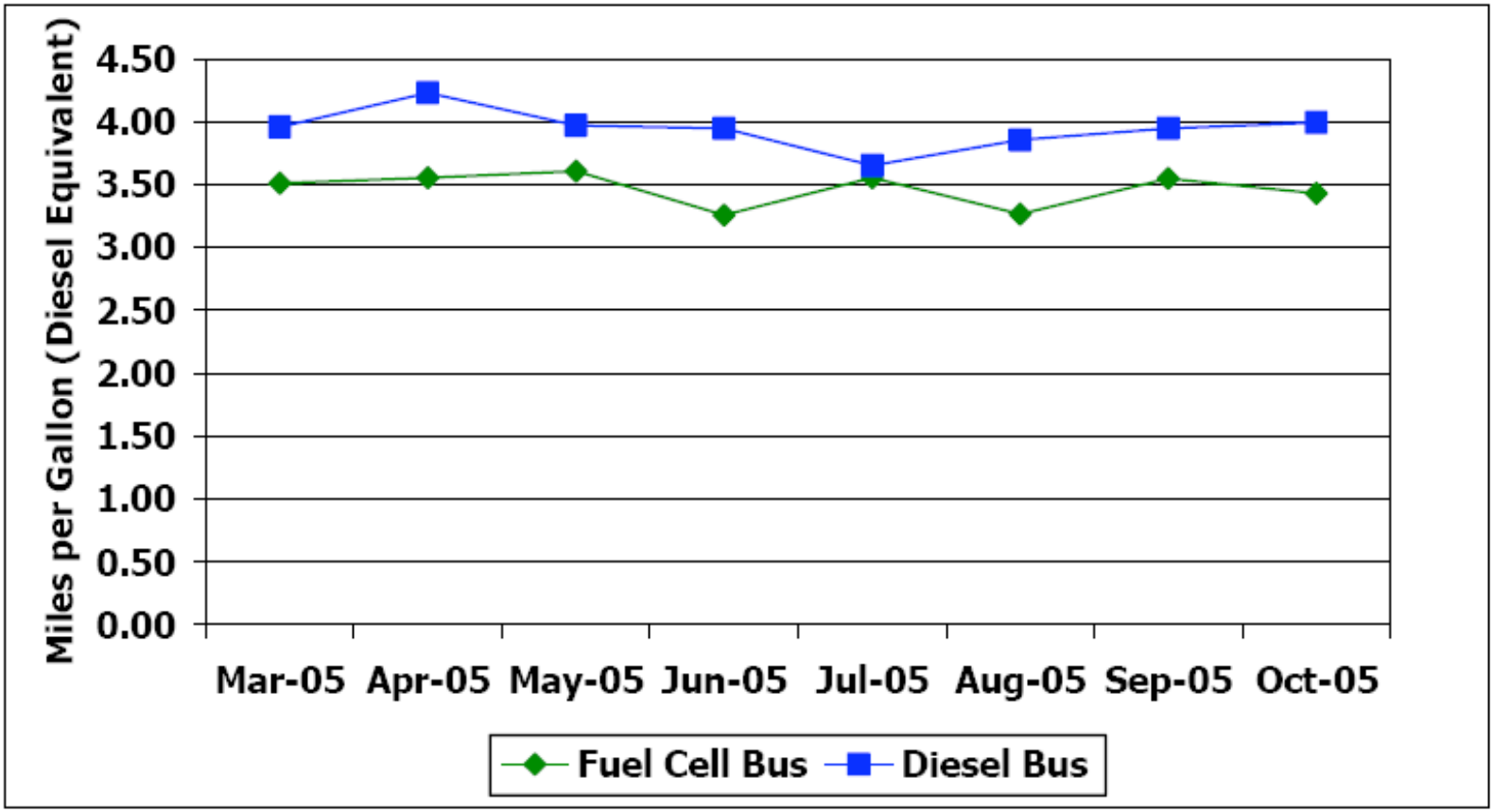


Figure 12. Average Fuel Economy (mpg) by Month

Hydrogen Fuel Prices for VTA

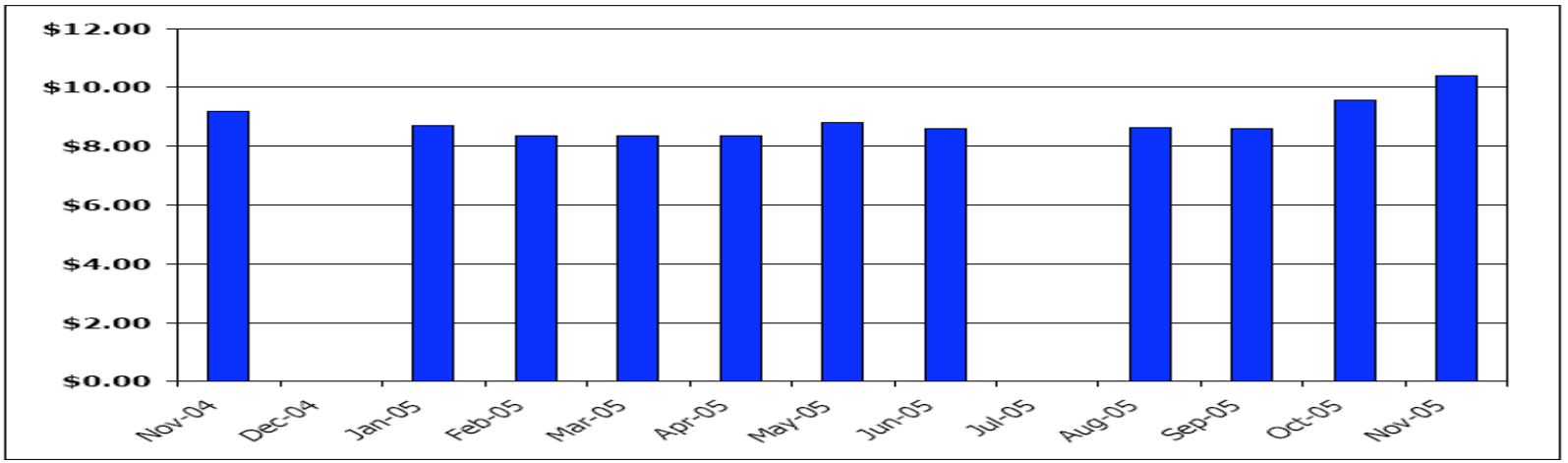


Figure 7. Average Price Paid ($/kg) for Liquid Hydrogen Delivered to VTA Station

Miles Between Road Calls	1,044 Fuel Cell 11,424 Diesel
Maintenance Costs per Mile	$4.26 Fuel Cell $0.59 Diesel
Monthly Average Miles Driven	726 Fuel Cell 4,284 Diesel

AC Transit

- Expected to operate 100-150 miles/day.
- Grand opening – March 13 in conjunction with NHA conference
- 8 miles per diesel gallon equivalent.

President Bush Visit

SunLine Transit

- November 16, 2005 official unveiling at the Fuel Cell Seminar
- December 16, 2005 first day of revenue service

SunLine Transit

- Typical operating shift
  - 8 hours of operation and 123 miles roundtrip
  - Average fuel economy is over 7 miles per gasoline gallon equivalent
- Bus has proven capability to operate a 16 hour day and 230 miles with the ability to go farther.
- Current odometer – 14,000 miles

Other Demonstrations

China

CUTE

ecobus
ZERO EMISSIONS
GOVERNMENT OF WESTERN AUSTRALIA

Japan

Sample Comparative Fuel Economy Data

Site	Fuel Economy (mi/dge)
Perth, Australia	3.7
London	2.6
Japan	6.0
Sunline (estimated)	8.0
AC Transit (estimated)	8.0
Santa Clara	3.4
Average Diesel Transit Bus	3.5

Fuel Cell Buses

AC Transit	3
Santa Clara VTA	3
SunLine	1
Amsterdam	3
Barcelona	3
Hamburg	9
London	3
Luxembourg	3
Madrid	3
Reykjavik	3
Perth	3
Beijing	3

40 buses operating with more to come

DART

BC Transit

Regional Transportation Commission RTC of Southern Nevada

Research Needs

Fuel cell system	Durability	Market Readiness	Emissions Target	Fuel Efficiency Target	Cost
Gen I 2003-2007	2 year useful life for fuel cell system	Limited revenue service capable, (mostly demo/data collection)	Exceed 2004 EPA and CARB emissions standards for transit bus (ZEV or PZEV)	Exceed fuel efficiency of comparable standard transit bus by 25-percent	Cost about 10 times the cost of comparable 40-foot transit bus
Gen II 2007-2010	4-6 year useful life for fuel cell system	Revenue service capable	Exceed EPA 2007 transit bus emissions standards	Fuel efficiency equivalency of 7-mpg	Cost less than 4 times comparable transit bus
Gen III 2010-2015 +	6 year useful life for fuel cell system, multiple suppliers of fuel cell system	Revenue service operational	Exceed all transit bus emissions standards, ZEV or PZEV	Fuel efficiency equivalency of 10-mpg	Cost less than 2 times comparable transit bus